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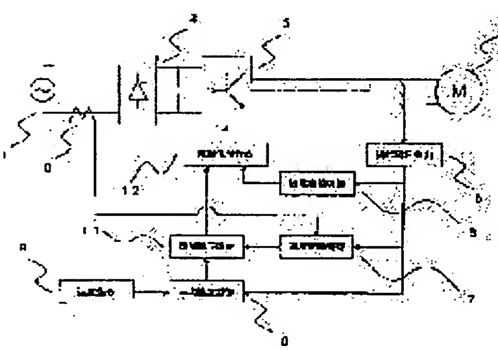
(54) VELOCITY CONTROLLER OF DC BRUSHLESS MOTOR



(57)Abstract:
PROBLEM TO BE SOLVED: To prevent breakdown by an excessive current of a semiconductor switching element to drive a brushless motor without use of a complicated current control system.
SOLUTION: An induced voltage detecting section 5 obtains a position detecting signal of a rotor and a power feeding coil switching section 6 sequentially switches a stator coil. Moreover, a velocity variation control section 7 detects velocity variation during rotation of motor 1 from the position detecting signal and also obtains amount of change of voltage applied to the motor 1 during rotation to control velocity variation depending on a current detected by a motor operation current detecting section 8. Next, an average velocity control section 10 compares a moor average velocity calculated from the position detecting signal with a command from a velocity command section 9 to obtain an average application voltage of motor 1 during rotation. In addition, an application voltage varying section 11 varies the average application voltage of motor and also varies momentary application voltage of motor obtained in the velocity variation control section 7 to determine the application voltage of motor. A drive signal generating section 12 generates a drive signal of a semiconductor switching element group 3 to driven the motor 4 based on the application voltage obtained as explained above.

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CLAIMS

[Claim(s)]
[Claim 1] While having two or more stator windings arranged so that rotating magnetic field may be given to this rotator at the time of the rotator and energization which have the permanent magnet of two or more poles, energizing to some stator windings of two or more of these stator windings and obtaining rotating magnetic field Detect change of the induced voltage produced by the revolution of a rotator in the stator winding which is not energized, and a location detecting signal is obtained. The stator winding energized based on this location detecting signal is switched one by one. In DC brushless-motor control unit accomplished so that the rotator velocity turbulence under rotator 1 revolution might be controlled and the applied voltage to a stator winding might be changed during rotator 1 revolution The speed regulating device of DC brushless motor characterized by embracing the detected motor operation current and reducing the amount of electrical-potential-difference modification under rotator 1 revolution when a motor operation current detection means is established and a predetermined value is reached.
[Claim 2] While having two or more stator windings arranged so that rotating magnetic field may be given to this rotator at the time of the rotator and energization which have the permanent magnet of two or more poles, energizing to some stator windings of two or more of these stator windings and obtaining rotating magnetic field Detect change of the induced voltage produced by the revolution of a rotator in the stator winding which is not energized, and a location detecting signal is obtained. The stator winding energized based on this location detecting signal is switched one by one. In DC brushless-motor control unit accomplished so that the rotator velocity turbulence under rotator 1 revolution might be controlled and the applied voltage to a stator winding might be changed during rotator 1 revolution The speed regulating device of DC brushless motor characterized by responding to the average applied voltage and reducing the amount of electrical-potential-difference modification under rotator 1 revolution when the average applied voltage to the stator winding under rotator 1 revolution reaches a predetermined value.
[Claim 3] While having two or more stator windings arranged so that rotating magnetic field may be given to this rotator at the time of the rotator and energization which have the permanent magnet of two or more poles, energizing to some stator windings of two or more of these stator windings and obtaining rotating magnetic field Detect change of the induced voltage produced by the revolution of a rotator in the stator winding which is not energized, and a location detecting signal is obtained. The stator winding energized based on this location detecting signal is switched one by one. In DC brushless-motor control unit accomplished so that the rotator velocity turbulence under rotator 1 revolution might be controlled and the applied voltage to a stator winding might be changed during rotator 1 revolution The speed regulating device

of DC brushless motor characterized by preparing the maximum applying voltage under rotator 1 revolution according to the detected motor operation current when a motor operation current detection means is established and a predetermined value is reached.
[Claim 4] While having two or more stator windings arranged so that rotating magnetic field may be given to this rotator at the time of the rotator and energization which have the permanent magnet of two or more poles, energizing to some stator windings of two or more of these stator windings and obtaining rotating magnetic field Detect change of the induced voltage produced by the revolution of a rotator in the stator winding which is not energized, and a location detecting signal is obtained. The stator winding energized based on this location detecting signal is switched one by one. In DC brushless-motor control unit accomplished so that the rotator velocity turbulence under rotator 1 revolution might be controlled and the applied voltage to a stator winding might be changed during rotator 1 revolution The speed regulating device of DC brushless motor characterized by preparing the maximum applying voltage under rotator 1 revolution according to average applied voltage when the average applied voltage to the stator winding under rotator 1 revolution reaches a predetermined value.
[Claim 5] The speed regulating device of DC brushless motor according to claim 3 or 4 characterized by setting up so that it may decrease with the maximum applying voltage under rotator 1 revolution to the increment in the average applied voltage under rotator 1 revolution.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention switches the stator winding which energizes the induced voltage which has the permanent magnet of two or more poles, and produces by the revolution of a rotator based on the location detecting signal detected and obtained one by one, and relates to the speed regulating device of the load which changes [be / it / under / 1 revolution / of a brushless motor / setting] with periodicity, for example, the DC brushless motor suitable for driving the compressor of an air conditioner, in the control device of the brushless motor which carries out adjustable [of the electrical potential difference impressed to a stator winding], and controlled the rate of a rotator.
[0002]
[Description of the Prior Art] As such a conventional technique, the thing of a publication is in a Japanese Patent Publication No. 6 1 No. 48916 official report. A thing given in the above-mentioned official report is the speed regulating device which corrects the current data or electrical-potential-difference data which was carried out, and which was set up for every section, and corrected n n division data in the motor 1 revolution n division so that n division of the predetermined period of the load which joins DC brushless motor may be carried out and it may become equal about the rate of the divided adjacent section.
[0003] In the part where the load under brushless-motor 1 revolution is small, electrical-potential-difference data or current data is decreased, and it is made for the load under brushless-motor 1 revolution to make electrical-potential-difference data or current data increase in a thing given in the above-mentioned official report in a large part.
[0004] However, it is the motor which performs such control, for example, there is fluctuation of the load under 1 revolution like the compressor of an air conditioner. And when driving what the difference of a load effect in the time of a low-speed revolution (the range of a motor rotational frequency is operation by about 3000 or less rpm) produces greatly In the part to which electrical-potential-difference data or current data is made to increase, there is a possibility that the current protection for preventing the current protection for

preventing destruction of the solid-state-switching component which drives a brushless motor, or demagnetization of the permanent magnet of a brushless-motor rotator may work.

[0005] Although control becomes complicated, in order to control the current itself by the speed regulating device which corrected current data, it is comparatively easy to avoid current protection. On the contrary, in the speed regulating device which corrected electrical-potential-difference data, although current detection equipment was not needed but control was comparatively easy, since the current was decided as a result of having controlled the electrical potential difference, there was a problem of becoming easy to commit current protection.

[0006]

[The technical problem which invention will solve and to carry out] This invention is made in order to solve the above-mentioned trouble, and it aims at offering the speed regulating device of DC brushless motor which can prevent **** by the excess current of the permanent magnet of a brushless-motor rotator while it can prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution.

[0007]

[Means for Solving the Problem] The speed regulating device of DC brushless motor concerning claim 1 of this invention While having two or more stator windings arranged so that rotating magnetic field may be given to this rotator at the time of the rotator and energization which have the permanent magnet of two or more poles, energizing to some stator windings of two or more of these stator windings and obtaining rotating magnetic field Detect change of the induced voltage produced by the revolution of a rotator in the stator winding which is not energized, and a location detecting signal is obtained. The stator winding energized based on this location detecting signal is switched one by one. In DC brushless-motor control unit accomplished so that the rotator velocity turbulence under rotator 1 revolution might be controlled and the applied voltage to a stator winding might be changed during rotator 1 revolution When a motor operation current detection means is established and a predetermined value is reached, it constitutes so that the detected motor operation current may be embraced and the amount of electrical-potential-difference modification under rotator 1 revolution may be reduced.

[0008] When the load which detects a motor operation current and is applied to a motor according to that motor current is distinguished and that motor operation current reaches a predetermined value by this The overcurrent of a motor current is controlled by decreasing the amount of modification of the motor applied voltage changed in order to lose the rotator velocity turbulence under rotator 1 revolution, and making it motor applied voltage not increase superfluously. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution, demagnetization by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.

[0009] The speed regulating device of DC brushless motor concerning claim 2 of this invention While having two or more stator windings arranged so that rotating magnetic field may be given to this rotator at the time of the rotator and energization which have the permanent magnet of two or more poles, energizing to some stator windings of two or more of these stator windings and obtaining rotating magnetic field Detect change of the induced voltage produced by the revolution of a rotator in the stator winding which is not energized, and a location detecting signal is obtained. The stator winding energized based on this location detecting signal is switched one by one. In DC brushless-motor control unit accomplished so that the rotator velocity turbulence under rotator 1 revolution might be controlled and the applied voltage to a stator winding might be changed during rotator 1 revolution When the average applied voltage to the stator winding under rotator 1 revolution reaches a predetermined value, it constitutes so that it may respond to the average applied voltage and the amount of electrical-potential-difference modification under rotator 1 revolution may be reduced.

[0010] When the load applied to a motor with motor applied voltage is distinguished and that motor applied voltage reaches a predetermined value by this The overcurrent of a motor current is controlled by decreasing the amount of modification of the motor applied voltage changed in order to lose the rotator velocity turbulence under rotator 1 revolution, and making it motor applied voltage not increase superfluously. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current

under rotator 1 revolution, demagnetization by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.

[0011] The speed regulating device of DC brushless motor concerning claim 3 of this invention While having two or more stator windings arranged so that rotating magnetic field may be given to this rotator at the time of the rotator and energization which have the permanent magnet of two or more poles, energizing to some stator windings of two or more of these stator windings and obtaining rotating magnetic field Detect change of the induced voltage produced by the revolution of a rotator in the stator winding which is not energized, and a location detecting signal is obtained. The stator winding energized based on this location detecting signal is switched one by one. In DC brushless-motor control unit accomplished so that the rotator velocity turbulence under rotator 1 revolution might be controlled and the applied voltage to a stator winding might be changed during rotator 1 revolution When a motor operation current detection means is established and a predetermined value is reached, it constitutes so that the maximum applying voltage under rotator 1 revolution may be prepared according to the detected motor operation current.

[0012] When the load which detects a motor operation current and is applied to a motor according to that motor current is distinguished and that motor operation current reaches a predetermined value by this The overcurrent of a motor current is controlled by restricting the amount of modification of the motor applied voltage changed in order to lose the rotator velocity turbulence under rotator 1 revolution, and making it motor applied voltage not increase superfluously. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution, demagnetization by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.

[0013] The speed regulating device of DC brushless motor concerning claim 4 of this invention While having two or more stator windings arranged so that rotating magnetic field may be given to this rotator at the time of the rotator and energization which have the permanent magnet of two or more poles, energizing to some stator windings of two or more of these stator windings and obtaining rotating magnetic field Detect change of the induced voltage produced by the revolution of a rotator in the stator winding which is not energized, and a location detecting signal is obtained. The stator winding energized based on this location detecting signal is switched one by one. In DC brushless-motor control unit accomplished so that the rotator velocity turbulence under rotator 1 revolution might be controlled and the applied voltage to a stator winding might be changed during rotator 1 revolution When the average applied voltage to the stator winding under rotator 1 revolution reaches a predetermined value, it constitutes so that the maximum applying voltage under rotator 1 revolution may be prepared according to average applied voltage.

[0014] When the load applied to a motor with motor applied voltage is distinguished and that motor applied voltage reaches a predetermined value by this The overcurrent of a motor current is controlled by restricting the amount of modification of the motor applied voltage changed in order to lose the rotator velocity turbulence under rotator 1 revolution, and making it motor applied voltage not increase superfluously. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution, demagnetization by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.

[0015] The speed regulating device of DC brushless motor concerning claim 5 of this invention While having two or more stator windings arranged so that rotating magnetic field may be given to this rotator at the time of the rotator and energization which have the permanent magnet of two or more poles, energizing to some stator windings of two or more of these stator windings and obtaining rotating magnetic field Detect change of the induced voltage produced by the revolution of a rotator in the stator winding which is not energized, and a location detecting signal is obtained. The stator winding energized based on this location detecting signal is switched one by one. In DC brushless-motor control unit accomplished so that the rotator velocity turbulence under rotator 1 revolution might be controlled and the applied voltage to a stator winding might be changed during rotator 1 revolution When a motor operation current detection means is established and a predetermined value is reached, or when the average applied voltage to the stator winding under rotator 1 revolution reaches a predetermined value Corresponding to the detected motor operation current, according to average applied voltage, the maximum applying voltage under rotator 1 revolution is prepared, and it constitutes so that it may decrease with this maximum applying voltage to the increment in the average applied voltage under rotator 1 revolution and may set up.

[0016] When the load applied to a motor with the detected motor current or motor applied voltage is distinguished and a motor current or motor applied voltage reaches a predetermined value by this While restricting the amount of modification of the motor applied voltage changed in order to lose the rotator velocity turbulence under rotator 1 revolution The overcurrent of a motor current is controlled by making it motor applied voltage not increase superfluously by making limiting value of the amount of modification small with the increment in a motor current or motor applied voltage. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution, demagnetization by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.
[0017]
[Embodiment of the Invention] The example of this invention is explained based on a drawing. Control-block drawing of the example of this invention which relates to drawing 1 at claim 1 is shown. It is rectified by the rectifier circuit 2, and connects with the three-phase-circuit DC brushless motor 4 (it is hereafter described as a motor) through the solid-state-switching elements 3 by which three-phase-circuit bridge connection was carried out, and AC power supply 1 is driving the pulsating load which changes [be / it / under / motor 1 revolution / setting] with periodicity, for example, the compressor of an air conditioner.
[0018] In the induced voltage detecting element 5, change of induced voltage was detected from each motor terminal, the location detecting signal of a rotator has been obtained, and the stator winding energized based on the location detecting signal of a rotator which may have had change of induced voltage detected from each motor terminal in the induced voltage detecting element 5 is switched one by one in the energization coil change-over section 6.
[0019] Moreover, in the velocity turbulence control section 7, while detecting the velocity turbulence under motor 1 revolution from said location detecting signal, the amount of modification of the motor applied voltage under motor 1 revolution which controls the velocity turbulence according to the current detected by the motor operation current detecting element 8 is calculated.
[0020] Next, in the mean velocity control section 10, the command of the motor mean velocity computed from said location detecting signal and the rate command section 9 is compared, and the average applied voltage of motor 1 revolution is called for.
[0021] Furthermore, in the applied-voltage modification section 11, while a change of motor average applied voltage called for by the mean velocity control section 10 by the command of motor mean velocity and the rate command section 9 is made, a change by the motor instant applied voltage called for by the velocity turbulence control section 7 is made, and the motor applied voltage supplied to a motor is determined.
[0022] And in the driving signal creation section 12, based on the stator winding and motor applied voltage which were obtained by doing in this way and to energize, the driving signal of the solid-state-switching elements 3 is created, and the motor 4 is driven.
[0023] Drawing 3 explains modification of the applied voltage under motor 1 revolution. It will motor 1 be under revolution, and since it compares with the motor load torque 26 in the acceleration region 27, and motor generating torque becomes large, it compares with the motor load torque 26 in the slowdown region 28 and motor generating torque becomes small when a motor load with the pulsating period 24 is driven with the fixed applied voltage 25, the velocity turbulence of a rotator will arise.
[0024] Then, in the acceleration region 27, the motor applied voltage 25 was decreased so that a rotator might not accelerate, the motor applied voltage 25 was made to increase, the applied voltage 29 after electrical-potential-difference amendment was obtained so that a rotator might not slow down, rotator velocity turbulence is detected and the velocity turbulence of a rotator is controlled in the slowdown region 28 by operating a motor with the applied voltage 29 after the electrical-potential-difference amendment.
[0025] Drawing 4 explains modification of the applied voltage under motor 1 revolution according to the current detected by the motor operation current detecting element 8. Like the above-mentioned, the average applied voltage 33 under motor 1 revolution is changed, and the applied voltage 30 after electrical-potential-difference amendment is called for. The difference of the average applied voltage 33 and the applied voltage 30 after electrical-potential-difference amendment is the amount of applied-voltage modification here.
[0026] And when the current which operated the motor with the applied voltage 30 after the called-for electrical-potential-difference amendment, and was detected by the motor operation current detecting element 8 when the current detected by the motor operation current detecting element 8 had not reached a

predetermined value has reache[illegible]e predetermined value, it is [current [illegible]ection] VADJ about ASET and the amount of applied-voltage modification in A and a predetermined current value. Then, the following relational expression, [0027]

[Equation 1]

$$V'ADJ = VADJ \times [1-(A-ASET)/ASET] \quad .... (b)$$

Amended amount V'ADJ of applied-voltage modification which was alike, and was followed and calculated A motor is operated with the applied voltage 32 after the amount reduction of modification to depend. However, in the case of V'ADJ <0, it treats with V'ADJ =0.

[0028] Thereby, for motor applied voltage, the amount of electrical-potential-difference modification is V'ADJ. It becomes what became and approached the average applied voltage 33, and the further increment in the motor current in the increment castle 31 in a motor current where motor applied voltage rises is controlled.

[0029] Drawing 5 explains setting out of the predetermined motor operation current at the time of reducing the amount of applied-voltage modification under motor 1 revolution. The axis of abscissa of drawing 5 is N1 - N2, when it is a motor rotational frequency and operates the compressor of an air conditioner as a load. It is the range of about 500 to 9000 rpm, and an axis of ordinate is a motor operation current or motor average applied voltage.

[0030] And this invention targets the phenomenon at the time of operation by about 3000 or less rpm for the range of a motor rotational frequency. What is necessary is just to set a predetermined motor operation current to the larger current value 35, for example, the current value which are the amount reduction conditions of modification of the amount of applied-voltage modification, than the current value 34 corresponding to the motor rating which performs operation control, without reducing the amount of applied-voltage modification under motor 1 revolution.

[0031] in this way, when the load which detects a motor operation current and is applied to a motor according to the motor current is distinguished and the motor operation current reaches a predetermined value The overcurrent of a motor current is controlled by decreasing the amount of modification of the motor applied voltage changed in order to lose the rotator velocity turbulence under rotator 1 revolution, and making it motor applied voltage not increase superfluously. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution, demagnetization by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.

[0032] Control-block drawing of the example of this invention concerning claim 2 is shown in drawing 2 . the solid-state-switching elements to which AC power supply was carried out for 13, and three-phase-circuit bridge connection of a rectifier circuit and 15 was carried out for 14, and 16 -- a three-phase-circuit DC brushless motor and 17 -- an induced voltage detecting element and 18 -- the energization coil change-over section and 19 -- a velocity turbulence control section and 20 -- the rate command section and 21 -- a mean velocity control section and 22 -- the applied-voltage modification section and 22 -- driving signal creation ******. Here, it is the same as that of the example which should explain about the actuation in the velocity turbulence control section 19, and was shown in drawing 1 about each actuation of those other than this, and explanation is omitted.

[0033] In the velocity turbulence control section 19, while detecting the velocity turbulence under motor 1 revolution from the location detecting signal obtained by the induced voltage detecting element 17, the amount of modification of the motor applied voltage under motor 1 revolution which controls the velocity turbulence according to the motor average applied voltage obtained by the mean velocity control section 21 is calculated. The difference of the average applied voltage 33 and the applied voltage 30 after electrical-potential-difference amendment is the amount of applied-voltage modification here.

[0034] Drawing 4 explains modification of the applied voltage under motor 1 revolution according to the motor average applied voltage obtained by the mean velocity control section 21. When the applied voltage under motor 1 revolution was changed, the applied voltage 30 after electrical-potential-difference amendment was obtained, a motor is operated with the applied voltage 30 after the obtained electrical-potential-difference amendment when motor average applied voltage has not reached a predetermined value, and motor average applied voltage has reached the predetermined value, it is [applied voltage / motor average] VADJ about VSET and the amount of applied-voltage modification in V and a predetermined electrical-potential-difference value. Then, the following relational-expression (b), [0035]

[Equation 2]
V'ADJ=VADJ x [1-(V-VSET) /VSET] .... (b)
Amended amount V'ADJ of applied-voltage modification which was alike, and was followed and calculated A motor is operated with the applied voltage 32 after the amount reduction of modification to depend. However, in the case of V'ADJ <0, it treats with V'ADJ =0.
[0036] Drawing 5 explains setting out of the predetermined motor average applied voltage at the time of reducing the amount of applied-voltage modification under motor 1 revolution. What is necessary is just to set predetermined motor average applied voltage to the larger electrical-potential-difference value 35, for example, the electrical-potential-difference value which are the amount reduction conditions of modification of the amount of applied-voltage modification, than the electrical-potential-difference value 34 corresponding to the motor rating which performs operation control, without reducing the amount of applied-voltage modification under motor 1 revolution.
[0037] in this way, when the load applied to a motor with motor applied voltage is distinguished and the motor applied voltage reaches a predetermined value The overcurrent of a motor current is controlled by decreasing the amount of modification of the motor applied voltage changed in order to lose the rotator velocity turbulence under rotator 1 revolution, and making it motor applied voltage not increase superfluously. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution, demagnetization by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.
[0038] The example of this invention concerning claim 3 is explained. It is the configuration same as control-block drawing as drawing 1 , when a detection current does not reach a predetermined current, operation control is carried out, without restricting the amount of modification of the applied voltage under motor 1 revolution which controls the velocity turbulence under motor 1 revolution, and when a detection current reaches a predetermined current, the amount of modification of the applied voltage under motor 1 revolution is restricted.
[0039] What is necessary is to set up, as drawing 5 explained setting out of a predetermined current, and just to make it the amount of applied-voltage modification not cross the suitable range to a motor average electrical potential difference according to the following relational expression (Ha) about a limit of the amount of applied-voltage modification.
[0040]
[Equation 3]
Amount of applied-voltage modification <= motor average applied-voltage **alpha (alpha is a forward constant) .... (Ha)
[0041] in this way, when the load which detects a motor operation current and is applied to a motor according to the motor current is distinguished and the motor operation current reaches a predetermined value The overcurrent of a motor current is controlled by restricting the amount of modification of the motor applied voltage changed in order to lose the rotator velocity turbulence under rotator 1 revolution, and making it motor applied voltage not increase superfluously. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution, demagnetization by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.
[0042] The example of this invention concerning claim 4 is explained. It is the configuration same as control-block drawing as drawing 2 , when motor average applied voltage does not reach a predetermined electrical potential difference, operation control is carried out, without restricting the amount of modification of the applied voltage under motor 1 revolution which controls the velocity turbulence under motor 1 revolution, and when motor average applied voltage reaches a predetermined electrical potential difference, the amount of modification of the applied voltage under motor 1 revolution is restricted.
[0043] What is necessary is to set up, as drawing 5 </A> explained setting out of a predetermined electrical potential difference, and just to carry out according to said relational expression (Ha) about a limit of the amount of applied-voltage modification .
[0044] in this way, when the load applied to a motor with motor applied voltage is distinguished and the motor applied voltage reaches a predetermined value The overcurrent of a motor current is controlled by restricting the amount of modification of the motor applied voltage changed in order to lose the rotator

velocity turbulence under rotator 1 revolution, and making it motor applied voltage not increase superfluously. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution, demagnetization by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.

[0045] The example of this invention concerning claim 5 is explained. Operation control is carried out without restricting the amount of modification of the applied voltage under motor 1 revolution which is the configuration same as control-block drawing as drawing 1 or drawing 2 , and controls the velocity turbulence under motor 1 revolution when a detection current does not reach a predetermined current, or when motor average applied voltage does not reach a predetermined electrical potential difference. When a detection current reaches a predetermined current, or when motor average applied voltage reaches a predetermined electrical potential difference, the amount of modification of the applied voltage under motor 1 revolution is restricted.

[0046] What is necessary is to set up, as drawing 5 explained setting out of a predetermined current or a predetermined electrical potential difference, and just to carry out according to following relational-expression (d) or following (e) about a limit of the amount of applied-voltage modification.

[0047] It is [current / detection / current value / A and / predetermined] VSET about V and a predetermined electrical-potential-difference value in ASET and motor average applied voltage. The relation will be [0048] if it carries out.

[Equation 4]

Amount of applied-voltage modification <=alphax [1-(A-ASET) /ASET] (alpha>=0) ... (d)

Or [0049]

[Equation 5]

Amount of applied-voltage modification <=alphax [1-(V-VSET) /VSET] (alpha>=0) ... (e)

What is necessary is to come out, and for the amount of applied-voltage modification not to cross the suitable range to a motor average electrical potential difference, but to just be set up so that the range may narrow with the increment in a detection current or a motor average electrical potential difference so that it may be shown. However, in the case of amount <of applied-voltage modification 0, it treats with amount =of applied-voltage modification 0.

[0050] in this way, when the load applied to a motor with the detected motor current or motor applied voltage is distinguished and a motor current or motor applied voltage reaches a predetermined value While restricting the amount of modification of the motor applied voltage changed in order to lose the rotator velocity turbulence under rotator 1 revolution The overcurrent of a motor current is controlled by making it motor applied voltage not increase superfluously by making limiting value of the amount of modification small with the increment in a motor current or motor applied voltage. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution, demagnetization by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.

[0051]

[Effect of the Invention] Thus, the speed-control approach of DC brushless motor of this invention The load which detects a motor operation current and is applied to a motor according to the motor current is distinguished. When the motor operation current reaches a predetermined value, or when it distinguishes the load applied to a motor with motor applied voltage and the motor applied voltage reaches a predetermined value The amount of modification of the motor applied voltage changed in order to lose the rotator velocity turbulence under rotator 1 revolution is decreased. The overcurrent of a motor current is controlled by making it motor applied voltage not increase superfluously. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution, **** by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.

[0052] Moreover, the load which detects an operation current and is applied to a motor according to the motor current is distinguished. When the motor operation current reaches a predetermined value, or when it distinguishes the load applied to a motor with motor applied voltage and the motor applied voltage reaches a predetermined value The amount of modification of the motor applied voltage changed in order to lose the rotator velocity turbulence under rotator 1 revolution is restricted. Or the overcurrent of a motor current is

controlled by making it motor a[illegible]ed voltage not increase superfluously[illegible] making small limiting value of the amount of modification of motor applied voltage. While being able to prevent destruction by the excess current of the solid-state-switching component which drives a brushless motor, without needing the complicated current control system which controls the motor current under rotator 1 revolution, demagnetization by the excess current of the permanent magnet of a brushless-motor rotator can be prevented.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Control-block drawing showing the example of this invention.
[Drawing 2] Control-block drawing showing other examples of this invention.
[Drawing 3] Drawing showing the example of modification of the applied voltage under rotator 1 revolution.
[Drawing 4] Drawing showing the example which reduces the amount of modification of the applied voltage under rotator 1 revolution.
[Drawing 5] Drawing showing the example of setting out of a motor operation current and motor applied voltage.
[Description of Notations]
1 13 AC power supply
2 14 Rectifier circuit
3 15 Solid-state-switching elements
4 16 Three-phase-circuit DC brushless motor
5 17 Induced voltage detecting element
6 18 Energization coil change-over section
7 19 Velocity turbulence detecting element
8 Motor Operation Current Detecting Element
9 20 Rate command section
10 21 Mean velocity control section
12 23 Driving signal creation section
24 Pulsating Period of Motor Load
25 Motor Applied Voltage
26 Motor Load Torque
27 Acceleration Region
28 Slowdown Region
29 30 Applied voltage after electrical-potential-difference amendment
31 Increment Region in Motor Current
32 Applied Voltage after the Amount Reduction of Modification
33 Average Applied Voltage
34 Motor Rating
35 The Amount Reduction Conditions of Modification

[Translation done.]

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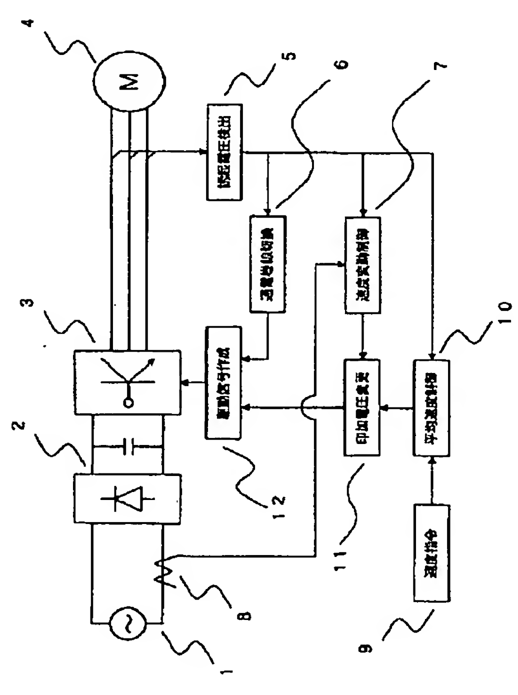
(54)【発明の名称】　ＤＣブラシレスモータの速度制御装置

(57)【要約】

【課題】　複雑な電流制御系を必要とせずに、ブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止する。

【解決手段】　誘起電圧検出部５では回転子の位置検出信号を得ており、通電巻線切換部６は通電する固定子巻線を順次切り換えている。また速度変動制御部７では、前記位置検出信号からモータ１回転中の速度変動を検出すると共にモータ運転電流検出部８で検出された電流に応じてその速度変動を抑制するモータ１回転中のモータ印加電圧の変更量が求められる。次に、平均速度制御部１０においては、前記位置検出信号から算出したモータ平均速度と速度指令部９の指令を比較しモータ１回転の平均印加電圧が求められる。更に、印加電圧変更部１１では、モータ平均印加電圧の変更が行われると共に、速度変動制御部７で求められたモータ瞬時印加電圧による変更が行われ、モータに供給するモータ印加電圧が決定される。そして駆動信号作成部１２では、このようにして得られたモータ印加電圧に基づき、半導体スイッチング素子群３の駆動信号を作成しモータ４を駆動する。



【特許請求の範囲】

【請求項１】　複数極の永久磁石を有する回転子と通電時にこの回転子に回転磁界を与えるように配置された複数の固定子巻線とを有し、この複数の固定子巻線のうちの幾つかの固定子巻線に通電して回転磁界を得るとともに、通電していない固定子巻線に回転子の回転によって生じる誘起電圧の変化を検出し位置検出信号を得、この位置検出信号に基づき通電する固定子巻線を順次切り換えるようにし、回転子１回転中の回転子速度変動を抑制するように固定子巻線への印加電圧を回転子１回転中において変更するように成したＤＣブラシレスモータ制御装置において、モータ運転電流検出手段を設け所定の値に達した場合に、検出したモータ運転電流に応じて回転子１回転中における電圧変更量を減ずることを特徴とするＤＣブラシレスモータの速度制御装置。

【請求項２】　複数極の永久磁石を有する回転子と通電時にこの回転子に回転磁界を与えるように配置された複数の固定子巻線とを有し、この複数の固定子巻線のうちの幾つかの固定子巻線に通電して回転磁界を得るとともに、通電していない固定子巻線に回転子の回転によって生じる誘起電圧の変化を検出し位置検出信号を得、この位置検出信号に基づき通電する固定子巻線を順次切り換えるようにし、回転子１回転中の回転子速度変動を抑制するように固定子巻線への印加電圧を回転子１回転中において変更するように成したＤＣブラシレスモータ制御装置において、回転子１回転中における固定子巻線への平均印加電圧が所定の値に達した場合に、その平均印加電圧に応じて回転子１回転中における電圧変更量を減ずることを特徴とするＤＣブラシレスモータの速度制御装置。

【請求項３】　複数極の永久磁石を有する回転子と通電時にこの回転子に回転磁界を与えるように配置された複数の固定子巻線とを有し、この複数の固定子巻線のうちの幾つかの固定子巻線に通電して回転磁界を得るとともに、通電していない固定子巻線に回転子の回転によって生じる誘起電圧の変化を検出し位置検出信号を得、この位置検出信号に基づき通電する固定子巻線を順次切り換えるようにし、回転子１回転中の回転子速度変動を抑制するように固定子巻線への印加電圧を回転子１回転中において変更するように成したＤＣブラシレスモータ制御装置において、モータ運転電流検出手段を設け所定の値に達した場合に、検出したモータ運転電流に応じて回転子１回転中の最大印加電圧を設けることを特徴とするＤＣブラシレスモータの速度制御装置。

【請求項４】　複数極の永久磁石を有する回転子と通電時にこの回転子に回転磁界を与えるように配置された複数の固定子巻線とを有し、この複数の固定子巻線のうちの幾つかの固定子巻線に通電して回転磁界を得るとともに、通電していない固定子巻線に回転子の回転によって生じる誘起電圧の変化を検出し位置検出信号を得、この位置検出信号に基づき通電する固定子巻線を順次切り換えるようにし、回転子１回転中の回転子速度変動を抑制するように固定子巻線への印加電圧を回転子１回転中において変更するように成したＤＣブラシレスモータ制御装置において、回転子１回転中における固定子巻線への平均印加電圧が所定の値に達した場合に、平均印加電圧に応じて回転子１回転中の最大印加電圧を設けることを特徴とするＤＣブラシレスモータの速度制御装置。

【請求項５】　回転子１回転中の最大印加電圧を、回転子１回転中の平均印加電圧の増加に伴い減少するように設定することを特徴とする請求項３または請求項４に記載のＤＣブラシレスモータの速度制御装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、複数極の永久磁石を有し回転子の回転によって生じる誘起電圧を検出して得られる位置検出信号に基づいて通電する固定子巻線を順次切り換えるようにし、固定子巻線に印加する電圧を可変して回転子の速度を制御するようにしたブラシレスモータの制御装置において、ブラシレスモータの１回転中において周期性をもって変化する負荷、例えば空気調和機のコンプレッサを駆動するのに適したＤＣブラシレスモータの速度制御装置に関するものである。

【０００２】

【従来の技術】このような従来技術としては、特公平６－４８９１６号公報に記載のものがある。上記公報に記載のものは、ＤＣブラシレスモータに加わる負荷の所定周期をｎ分割し、分割された隣り合う区間の速度を等しくなるようにｎ分割した区間毎に設定された電流データもしくは電圧データを修正するものであり、モータ１回転においてｎ個のｎ分割データを修正するようにした速度制御装置である。

【０００３】上記公報に記載のものにおいては、ブラシレスモータ１回転中の負荷が小さい個所では電圧データまたは電流データを減少させ、ブラシレスモータ１回転中の負荷が大きい個所では電圧データまたは電流データを増加させるようにする。

【０００４】しかしこのような制御を行なうモータで、例えば空気調和機のコンプレッサのように１回転中の負荷の変動があり、しかも低速回転時（モータ回転数の範囲は約３０００ｒｐｍ以下での運転）での、負荷変動の差が大きく生じるものを駆動する場合は、電圧データまたは電流データを増加させる個所では、ブラシレスモータを駆動する半導体スイッチング素子の破壊を防止するための電流保護、あるいはブラシレスモータ回転子の永久磁石の減磁を防止するための電流保護が働く恐れがある。

【０００５】電流データを修正するようにした速度制御装置では、制御は複雑になるが電流そのものを制御するため電流保護を回避することは比較的容易である。逆

に、電圧データを修正するようにした速度制御装置では、電流検出装置を必要とせず制御は比較的容易であるが、電圧を制御した結果として電流が決まるので電流保護が働き易くなるという問題があった。

【０００６】

【発明が解決しようとする課題】本発明は、上記問題点を解決するためになされたものであり、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずに、ブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止できるとともに、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できるＤＣブラシレスモータの速度制御装置を提供することを目的とするものである。

【０００７】

【課題を解決するための手段】本発明の請求項１に係るＤＣブラシレスモータの速度制御装置は、複数極の永久磁石を有する回転子と通電時にこの回転子に回転磁界を与えるように配置された複数の固定子巻線とを有し、この複数の固定子巻線のうちの幾つかの固定子巻線に通電して回転磁界を得るとともに、通電していない固定子巻線に回転子の回転によって生じる誘起電圧の変化を検出し位置検出信号を得、この位置検出信号に基づき通電する固定子巻線を順次切り換えるようにし、回転子１回転中の回転子速度変動を抑制するように固定子巻線への印加電圧を回転子１回転中において変更するように成したＤＣブラシレスモータ制御装置において、モータ運転電流検出手段を設け所定の値に達した場合に、検出したモータ運転電流に応じて回転子１回転中における電圧変更量を減ずるように構成する。

【０００８】このことにより、モータ運転電流を検出しそのモータ電流によりモータにかかる負荷を判別し、そのモータ運転電流が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を減少させモータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【０００９】本発明の請求項２に係るＤＣブラシレスモータの速度制御装置は、複数極の永久磁石を有する回転子と通電時にこの回転子に回転磁界を与えるように配置された複数の固定子巻線とを有し、この複数の固定子巻線のうちの幾つかの固定子巻線に通電して回転磁界を得るとともに、通電していない固定子巻線に回転子の回転によって生じる誘起電圧の変化を検出し位置検出信号を得、この位置検出信号に基づき通電する固定子巻線を順次切り換えるようにし、回転子１回転中の回転子速度変動を抑制するように固定子巻線への印加電圧を回転子１回転中において変更するように成したＤＣブラシレスモータ制御装置において、回転子１回転中における固定子巻線への平均印加電圧が所定の値に達した場合に、その平均印加電圧に応じて回転子１回転中における電圧変更量を減ずるように構成する。

【００１０】このことにより、モータ印加電圧によりモータにかかる負荷を判別し、そのモータ印加電圧が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を減少させモータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【００１１】本発明の請求項３に係るＤＣブラシレスモータの速度制御装置は、複数極の永久磁石を有する回転子と通電時にこの回転子に回転磁界を与えるように配置された複数の固定子巻線とを有し、この複数の固定子巻線のうちの幾つかの固定子巻線に通電して回転磁界を得るとともに、通電していない固定子巻線に回転子の回転によって生じる誘起電圧の変化を検出し位置検出信号を得、この位置検出信号に基づき通電する固定子巻線を順次切り換えるようにし、回転子１回転中の回転子速度変動を抑制するように固定子巻線への印加電圧を回転子１回転中において変更するように成したＤＣブラシレスモータ制御装置において、モータ運転電流検出手段を設け所定の値に達した場合に、検出したモータ運転電流に応じて回転子１回転中の最大印加電圧を設けるように構成する。

【００１２】このことにより、モータ運転電流を検出しそのモータ電流によりモータにかかる負荷を判別し、そのモータ運転電流が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を制限しモータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【００１３】本発明の請求項４に係るＤＣブラシレスモータの速度制御装置は、複数極の永久磁石を有する回転子と通電時にこの回転子に回転磁界を与えるように配置された複数の固定子巻線とを有し、この複数の固定子巻線のうちの幾つかの固定子巻線に通電して回転磁界を得るとともに、通電していない固定子巻線に回転子の回転によって生じる誘起電圧の変化を検出し位置検出信号を得、この位置検出信号に基づき通電する固定子巻線を順

次切り換えるようにし、回転子１回転中の回転子速度変動を抑制するように固定子巻線への印加電圧を回転子１回転中において変更するように成したＤＣブラシレスモータ制御装置において、回転子１回転中における固定子巻線への平均印加電圧が所定の値に達した場合に、平均印加電圧に応じて回転子１回転中の最大印加電圧を設けるように構成する。

【００１４】このことにより、モータ印加電圧によりモータにかかる負荷を判別し、そのモータ印加電圧が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を制限しモータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【００１５】本発明の請求項５に係るＤＣブラシレスモータの速度制御装置は、複数極の永久磁石を有する回転子と通電時にこの回転子に回転磁界を与えるように配置された複数の固定子巻線とを有し、この複数の固定子巻線のうちの幾つかの固定子巻線に通電して回転磁界を得るとともに、通電していない固定子巻線に回転子の回転によって生じる誘起電圧の変化を検出し位置検出信号を得、この位置検出信号に基づき通電する固定子巻線を順次切り換えるようにし、回転子１回転中の回転子速度変動を抑制するように固定子巻線への印加電圧を回転子１回転中において変更するように成したＤＣブラシレスモータ制御装置において、モータ運転電流検出手段を設け所定の値に達した場合に、又は回転子１回転中における固定子巻線への平均印加電圧が所定の値に達した場合に、検出したモータ運転電流に応じて、又は平均印加電圧に応じて回転子１回転中の最大印加電圧を設け、該最大印加電圧を、回転子１回転中の平均印加電圧の増加に伴い減少するように設定するように構成する。

【００１６】このことにより、検出したモータ電流あるいはモータ印加電圧によりモータにかかる負荷を判別し、モータ電流あるいはモータ印加電圧が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を制限するとともに、モータ電流あるいはモータ印加電圧の増加に伴い変更量の制限値を小さくすることによりモータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイツチング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【００１７】

【発明の実施の形態】本発明の実施例を図面に基づき説明する。図１に請求項１に係る本発明の実施例の制御ブロック図を示す。交流電源１は整流回路２により整流され３相ブリッジ結線された半導体スイッチング素子群３を介して３相ＤＣブラシレスモータ４（以下、モータと記す）に接続され、モータ１回転中において周期性をもって変化する脈動負荷、例えば空気調和機のコンプレッサを駆動している。

【００１８】誘起電圧検出部５においては、各モータ端子から誘起電圧の変化を検出し回転子の位置検出信号を得ており、通電巻線切換部６においては、誘起電圧検出部５において各モータ端子から誘起電圧の変化を検出し得られた回転子の位置検出信号に基づき通電する固定子巻線を順次切り換えている。

【００１９】また速度変動制御部７においては、前記位置検出信号からモータ１回転中の速度変動を検出すると共にモータ運転電流検出部８で検出された電流に応じてその速度変動を抑制するモータ１回転中のモータ印加電圧の変更量が求められる。

【００２０】次に、平均速度制御部１０においては、前記位置検出信号から算出したモータ平均速度と速度指令部９の指令を比較しモータ１回転の平均印加電圧が求められる。

【００２１】更に、印加電圧変更部１１においては、モータ平均速度と速度指令部９の指令により平均速度制御部１０で求められたモータ平均印加電圧の変更が行われると共に、速度変動制御部７で求められたモータ瞬時印加電圧による変更が行われ、モータに供給するモータ印加電圧が決定される。

【００２２】そして、駆動信号作成部１２においては、このようにして得られた通電する固定子巻線とモータ印加電圧に基づき、半導体スイッチング素子群３の駆動信号を作成しモータ４を駆動している。

【００２３】図３により、モータ１回転中の印加電圧の変更について説明する。脈動周期２４をもつモータ負荷を一定の印加電圧２５にて駆動した場合、加速域２７においてはモータ負荷トルク２６に比しモータ発生トルクが大きくなり減速域２８においてはモータ負荷トルク２６に比しモータ発生トルクが小さくなるので、モータ１回転中で回転子の速度変動が生じてしまう。

【００２４】そこで回転子速度変動を検出し、加速域２７では回転子が加速しないようにモータ印加電圧２５を減少させ、減速域２８では回転子が減速しないようにモータ印加電圧２５を増加させて電圧補正後の印加電圧２９を得、その電圧補正後印加電圧２９にてモータを運転することにより回転子の速度変動を抑制している。

【００２５】図４により、モータ運転電流検出部８で検出された電流に応じたモータ１回転中の印加電圧の変更について説明する。前述の如くモータ１回転中の平均印加電圧３３が変更されて電圧補正後の印加電圧３０が求められる。ここで平均印加電圧３３と電圧補正後の印加

電圧３０との差が印加電圧変更量である。

【００２６】そしてモータ運転電流検出部８で検出された電流が所定の値に達していない場合は、求められた電圧補正後の印加電圧３０にてモータを運転し、モータ運転電流検出部８で検出された電流が所定の値に達している場合は、検出電流をＡ，所定電流値をＡSET，印加電圧変更量をV_{ADJ}とすれば次の関係式、

【００２７】

【数１】

$$V'_{ADJ} = V_{ADJ} \times [1-(A-A_{SET}) \div A_{SET}] \cdots\cdots (イ)$$

に従って求められた補正された印加電圧変更量V'_{ADJ}による変更量減少後の印加電圧３２にてモータを運転するようにするものである。但し、$V'_{ADJ}<0$の場合は$V'_{ADJ}=0$と扱う。

【００２８】これにより、モータ印加電圧は電圧変更量がV'_{ADJ}となって平均印加電圧３３に近づいたものとなり、モータ印加電圧が上昇するモータ電流増加域３１におけるモータ電流の更なる増加を抑制するものである。

【００２９】図５により、モータ１回転中の印加電圧変更量を減ずる際の所定のモータ運転電流の設定について説明する。図５の横軸はモータ回転数であり、負荷として空気調和機のコンプレッサを運転する場合は、N_1～N_2は約５００～９０００ｒｐｍの範囲であり、縦軸はモータ運転電流あるいはモータ平均印加電圧である。

【００３０】そして本発明はモータ回転数の範囲は約３０００ｒｐｍ以下での運転時の現象を対象とするものである。所定のモータ運転電流は、モータ１回転中の印加電圧変更量を減ずることなく運転制御を行なうモータ定格に対応する電流値３４より大きい電流値、例えば印加電圧変更量の変更量減少条件である電流値３５に設定すればよい。

【００３１】こうして、モータ運転電流を検出しそのモータ電流によりモータにかかる負荷を判別し、そのモータ運転電流が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を減少させモータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【００３２】請求項２に係る本発明の実施例の制御ブロック図を図２に示す。１３は交流電源、１４は整流回路、１５は３相ブリッジ結線された半導体スイッチング素子群、１６は３相ＤＣブラシレスモータ、１７は誘起電圧検出部、１８は通電巻線切換部、１９は速度変動制御部、２０は速度指令部、２１は平均速度制御部、２２は印加電圧変更部、２２は駆動信号作成部ある。ここでは、速度変動制御部１９における動作について説明するものとし、これ以外の各動作については図１に示した実施例と同様であり説明は省略する。

【００３３】速度変動制御部１９においては、誘起電圧検出部１７で得られた位置検出信号からモータ１回転中の速度変動を検出すると共に、平均速度制御部２１で得られたモータ平均印加電圧に応じてその速度変動を抑制するモータ１回転中のモータ印加電圧の変更量が求められる。ここで平均印加電圧３３と電圧補正後の印加電圧３０との差が印加電圧変更量である。

【００３４】図４により、平均速度制御部２１で得られたモータ平均印加電圧に応じたモータ１回転中の印加電圧の変更について説明する。モータ１回転中の印加電圧が変更されて電圧補正後の印加電圧３０が得られ、モータ平均印加電圧が所定の値に達していない場合には得られた電圧補正後の印加電圧３０にてモータを運転し、モータ平均印加電圧が所定の値に達している場合にはモータ平均印加電圧をＶ，所定電圧値をV_{SET}，印加電圧変更量をV_{ADJ}とすれば次の関係式（ロ）、

【００３５】

【数２】

$$V'_{ADJ} = V_{ADJ} \times [1-(V-V_{SET}) \div V_{SET}] \cdots\cdots (ロ)$$

に従って求められた補正された印加電圧変更量V'_{ADJ}による変更量減少後の印加電圧３２にてモータを運転するようにするものである。但し、$V'_{ADJ}<0$の場合は$V'_{ADJ}=0$と扱う。

【００３６】図５により、モータ１回転中の印加電圧変更量を減ずる際の所定のモータ平均印加電圧の設定について説明する。所定のモータ平均印加電圧は、モータ１回転中の印加電圧変更量を減ずることなく運転制御を行なうモータ定格に対応する電圧値３４より大きい電圧値、例えば印加電圧変更量の変更量減少条件である電圧値３５に設定すればよい。

【００３７】こうして、モータ印加電圧によりモータにかかる負荷を判別し、そのモータ印加電圧が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を減少させモータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【００３８】請求項３に係る本発明の実施例について説明する。制御ブロック図としては図１と同様の構成であり、検出電流が所定電流に達しない場合にはモータ１回

転中の速度変動を抑制するモータ１回転中の印加電圧の変更量を制限せずに運転制御し、検出電流が所定電流に達した場合にモータ１回転中の印加電圧の変更量を制限するものである。

【００３９】所定電流の設定については図５で説明した＊如く設定し、印加電圧変更量の制限については次の関係式（ハ）に従い印加電圧変更量がモータ平均電圧に対して適当な範囲を越えないようにすればよい。

【００４０】

【数３】

$$印加電圧変更量 \leqq モータ平均印加電圧 \pm \alpha \ (\alpha は正の定数) \cdots\cdots (ハ)$$

【００４１】こうして、モータ運転電流を検出しそのモータ電流によりモータにかかる負荷を判別し、そのモータ運転電流が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を制限しモータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【００４２】請求項４に係る本発明の実施例について説明する。制御ブロック図としては図２と同様の構成であり、モータ平均印加電圧が所定電圧に達しない場合にはモータ１回転中の速度変動を抑制するモータ１回転中の印加電圧の変更量を制限せずに運転制御し、モータ平均印加電圧が所定電圧に達した場合にモータ１回転中の印加電圧の変更量を制限するものである。

【００４３】所定電圧の設定については図５で説明した如く設定し、印加電圧変更量の制限については前記関係式（ハ）に従い実施すればよい。

【００４４】こうして、モータ印加電圧によりモータにかかる負荷を判別し、そのモータ印加電圧が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を制限しモ※ータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【００４５】請求項５に係る本発明の実施例について説明する。制御ブロック図としては図１あるいは図２と同様の構成であり、検出電流が所定電流に達しない場合もしくはモータ平均印加電圧が所定電圧に達しない場合にはモータ１回転中の速度変動を抑制するモータ１回転中の印加電圧の変更量を制限せずに運転制御し、検出電流が所定電流に達した場合もしくはモータ平均印加電圧が所定電圧に達した場合にモータ１回転中の印加電圧の変更量を制限するものである。

【００４６】所定電流あるいは所定電圧の設定については図５で説明した如く設定し、印加電圧変更量の制限については次の関係式（ニ）あるいは（ホ）に従い実施すればよい。

【００４７】検出電流をＡ．所定電流値をA_{SET}，モータ平均印加電圧をＶ．所定電圧値をV_{SET} とすればその関係は、

【００４８】

【数４】

$$印加電圧変更量 \leqq \alpha \times [1-(A-A_{SET}) \div A_{SET}] \ (\alpha \geqq 0) \cdots (ニ)$$

あるいは、

【００４９】

★【数５】

$$印加電圧変更量 \leqq \alpha \times [1-(V-V_{SET}) \div V_{SET}] \ (\alpha \geqq 0) \cdots (ホ)$$

で示されるように、印加電圧変更量がモータ平均電圧に対して適当な範囲を越えず、その範囲が検出電流あるいはモータ平均電圧の増加に伴い狭まるように設定されればよい。但し、印加電圧変更量＜０の場合は印加電圧変更量＝０と扱う。

【００５０】こうして、検出したモータ電流あるいはモータ印加電圧によりモータにかかる負荷を判別し、モータ電流あるいはモータ印加電圧が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を制限するとともに、モータ電流あるいはモータ印加電圧の増加に伴い変更量の制限値を小さくすることによりモータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【００５１】

【発明の効果】このように本発明のＤＣブラシレスモータの速度制御方法は、モータ運転電流を検出しそのモータ電流によりモータにかかる負荷を判別し、そのモータ運転電流が所定の値に達した場合に、又はモータ印加電圧によりモータにかかる負荷を判別し、そのモータ印加電圧が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を減少させ、モータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイッチ

ング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【００５２】また、運転電流を検出しそのモータ電流によりモータにかかる負荷を判別し、そのモータ運転電流が所定の値に達した場合に、又はモータ印加電圧によりモータにかかる負荷を判別し、そのモータ印加電圧が所定の値に達した場合には、回転子１回転中の回転子速度変動をなくすために変更するモータ印加電圧の変更量を制限し、又はモータ印加電圧の変更量の制限値を小さくすることによりモータ印加電圧が過剰に増加しないようにすることでモータ電流の過電流を抑制し、回転子１回転中のモータ電流を制御する複雑な電流制御系を必要とせずにブラシレスモータを駆動する半導体スイッチング素子の過剰電流による破壊を防止できると共に、ブラシレスモータ回転子の永久磁石の過剰電流による減磁を防止できる。

【図面の簡単な説明】

【図１】本発明の実施例を示す制御ブロック図。

【図２】本発明の他の実施例を示す制御ブロック図。

【図３】回転子1回転中の印加電圧の変更例を示す図。

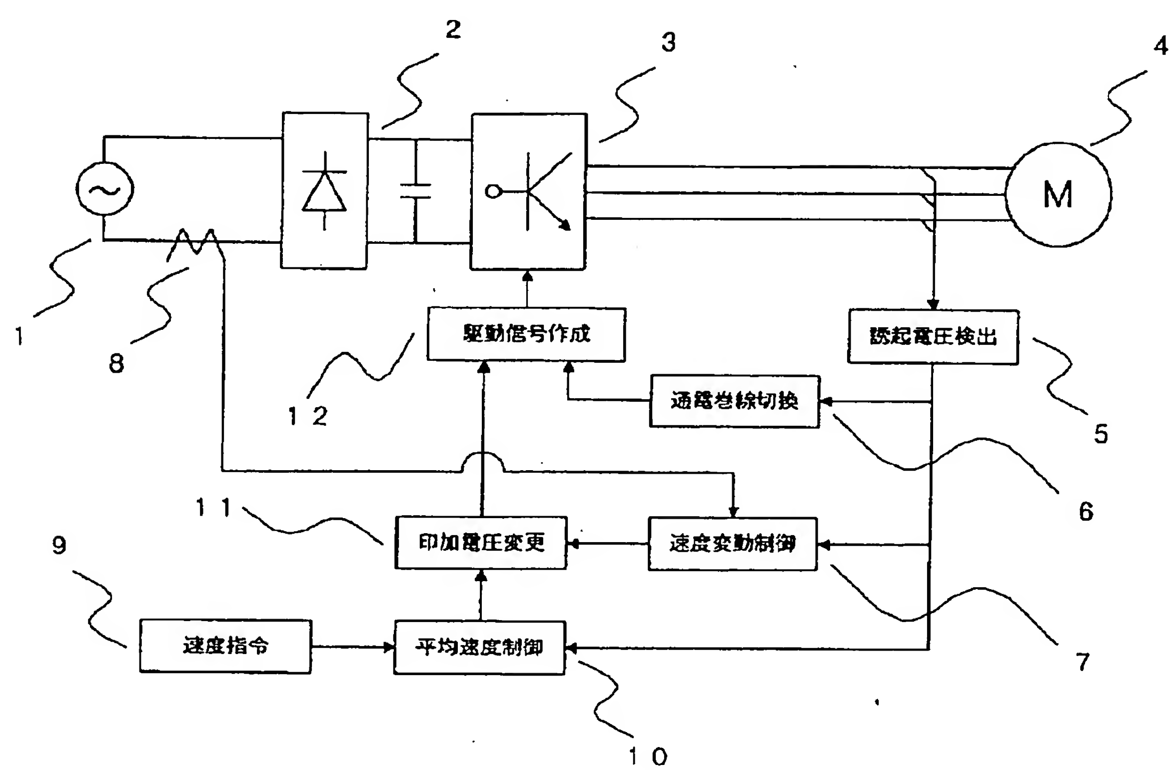
【図４】回転子１回転中の印加電圧の変更量を減ずる例を示す図。

【図５】モータ運転電流及びモータ印加電圧の設定例を示す図。

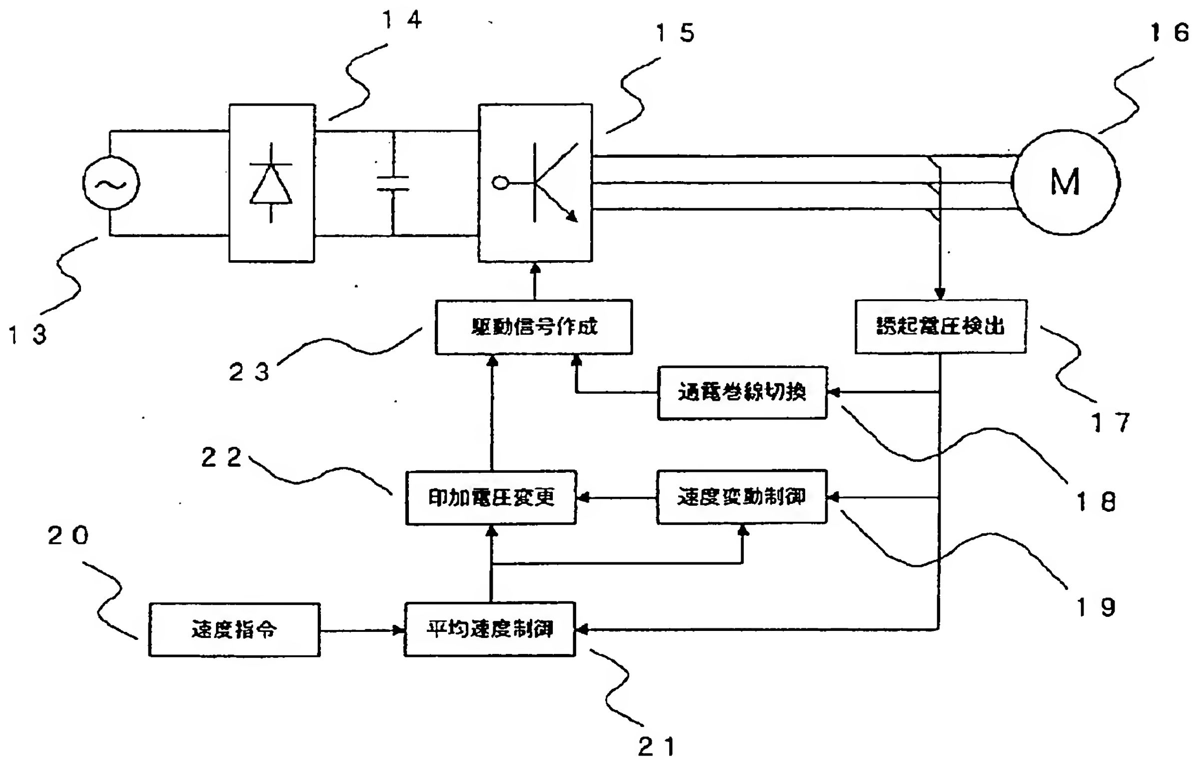
【符号の説明】

１，１３	交流電源
２，１４	整流回路
３，１５	半導体スイッチング素子群
４，１６	３相ＤＣブラシレスモータ
５，１７	誘起電圧検出部
６，１８	通電巻線切換部
７，１９	速度変動検出部
８	モータ運転電流検出部
９，２０	速度指令部
１０，２１	平均速度制御部
１２，２３	駆動信号作成部
２４	モータ負荷の脈動周期
２５	モータ印加電圧
２６	モータ負荷トルク
２７	加速域
２８	減速域
２９，３０	電圧補正後の印加電圧
３１	モータ電流増加域
３２	変更量減少後の印加電圧
３３	平均印加電圧
３４	モータ定格
３５	変更量減少条件

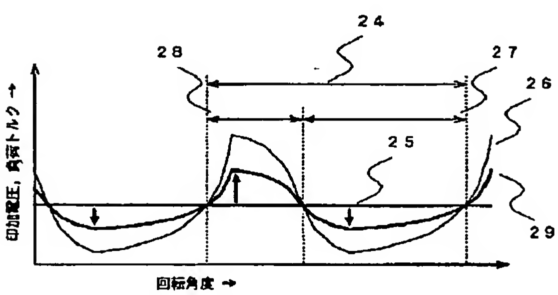
【図１】



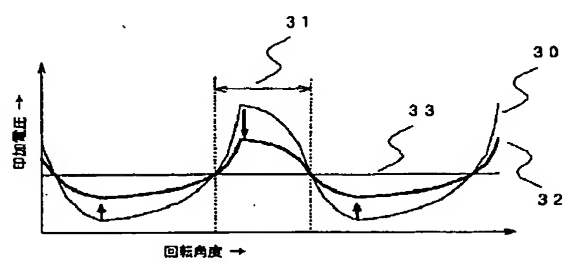
【図2】


14
15
16
M
13
駆動信号作成
誘起電圧検出
23
通電巻線切換
17
22
印加電圧変更
速度変動制御
18
20
19
速度指令
平均速度制御
21

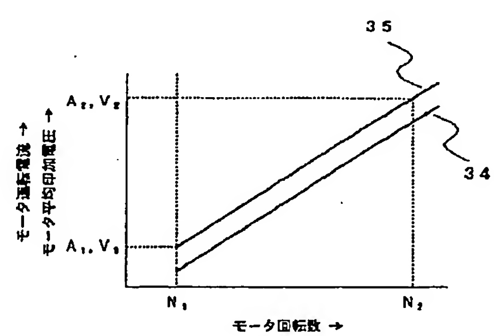
【図3】


24
28
27
26
25
29
印加電圧，負荷トルク →
回転角度 →

【図4】


31
30
33
32
印加電圧 →
回転角度 →

【図5】


35
A2, V2
34
A1, V1
N1
N2
モータ運転電流 →
モータ平均印加電圧 →
モータ回転数 →

フロントページの続き

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